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The mean duration of life is probably a little less than eight years. This curve affords a basis for comparing the growth of chitons in differing environments.

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[1] Contributions from the Bermuda Biological Station for Research, No. 96.

[2] Cf. Crozier, W. J., *Amer. Nat., New York,* (in press), and Arey, L. B., and Crozier, W. J., (in press), for an account of observations forming the starting point of these investigations.

[3] Winge, Ö., *Medd. Komm. Havunders., Fisk., Kobenhavn,* **4,** No. 8, 1915.

[4] Heath, H., *Zool. Anz., Leipzig,* **29,** 1905, (390–393).

GROWTH OF CHITON TUBERCULATUS IN DIFFERENT ENVIRONMENTS[1]

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Communicated by E. L. Mark, September 30, 1918

In the preceding paper a mean growth-curve for the chiton population of Great Sound, Bermuda, was derived from the examination of 1090 individuals, on the assumption, supported by collateral evidence, that the age of a chiton may be estimated from the markings upon its shell-plates. It was pointed out that curves of this kind might be used to study variations in the growth of Chiton tuberculatus in differing environments. A test of this suggestion is afforded by the comparison of the rates of growth and of the average duration of life of this species when living (1) in Great Sound, (2) on the south shore of Bermuda.

Even within the limits of Great Sound itself the chitons inhabiting the shores of the several islands may exhibit differing rates of growth, as indicated in figure 1. When two such islands as Long Island and Grace's Island are compared, it is found that the chitons from the former place grow somewhat less rapidly than do those from the latter, although the initial growth-rates are identical. Most of the Long Island chitons occur on the north shore of that island, which is a cliffed shore with many caves, sheltered from the sun but exposed to the beating of the sea during northwest winter gales. Grace's Island is more sheltered from storms.

On the other hand, chitons from an exposed beach on the south shore of Bermuda, such as that at Cross Bay, which supports a more numerous chiton population than do situations within the stiller waters of the Sound, grow at first more rapidly, but after the first year are smaller, as compared with those living in Great Sound.

The physical differences between two such environments as those presented by Long Island and by the beach at Cross Bay, include at least the following: the sea-water on the south shore is more alkaline, contains more oxygen, and is lower in temperature; the algal food for the chitons is not only specifically less abundant on the south shore, but there are also relatively more of the chitons requiring it; at Long Island more shelter is afforded, in crevices, from the sun's heat at intertidal periods; at Cross Bay the older chitons, which live further down the beach than do the younger ones,[2] are frequently covered to a depth of a foot or more by sand washed up by the tidal surf, and especially at times of southerly storms. The coöperation of these several differential

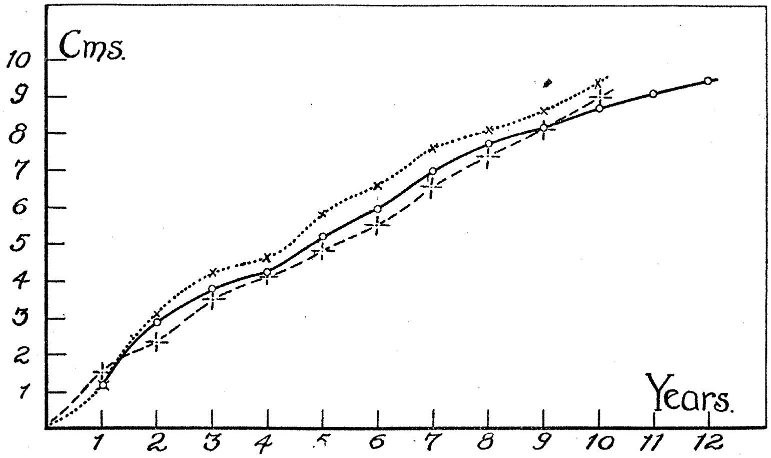

FIG. 1. THE RELATIVE GROWTH OF CHITON TUBERCULATUS IN DIFFERENT ENVIRONMENTS

——o—— Long Island, Great Sound (422 individuals). ······×······ Grace's Island, Great Sound (81 individuals). — —+— — Cross Bay, South Shore (591 individuals).

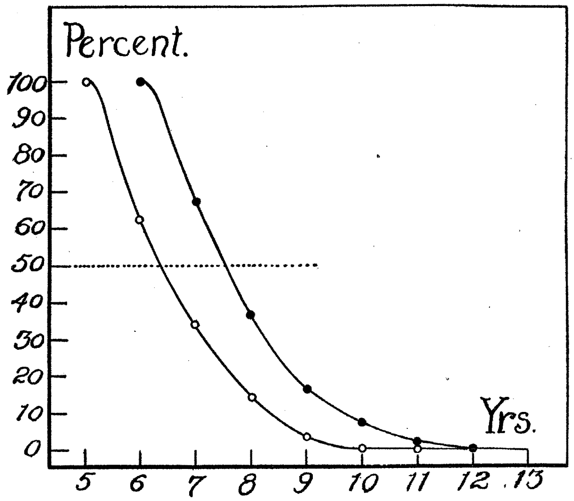

FIG. 2. THE PERCENTAGE SURVIVAL OF CHITONS ATTAINING THE AGE AT WHICH DYING-OFF BEGINS

● = Great Sound (515 individuals); ○ = Cross Bay, south shore (396 individuals).

influences is reflected in the fact that the chitons at Cross Bay die more quickly than do those in Great Sound (fig. 2).

The death rate is not the same for the two sexes. According to the results embodied in figure 3, the female chitons, on the whole, tend to die off more rapidly than do the males. This results in a preponderance of males among the oldest members of the population.

Independently of this effect, however, there are apparent in the present data some curious variations in the proportion of the sexes within the successive age-groups. The fact that these variations have been found in two distinct localities favors the view that one is not dealing with chance fluctuation. With one exception[3] the Placophora are, so far as is known, dioecious, and in Chiton tuberculatus the sexes are readily distinguishable. To what extent the fluctuations exhibited in the sex-ratio are due to environmental influences must be decided by further observation.

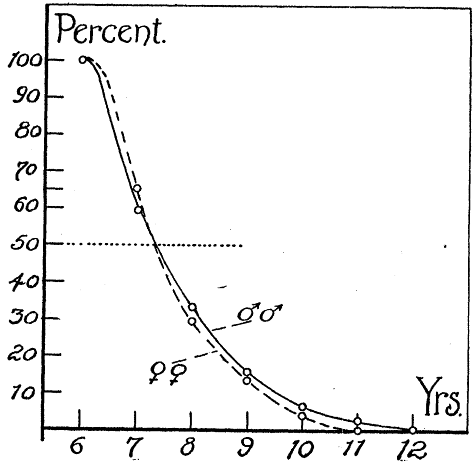

FIG. 3. THE RELATIVE DEATH-RATES OF MALES AND FEMALES (FROM RECORDS OF 912 INDIVIDUALS)

The sex of 1518 chitons was determined by dissection. The percentage of males ($R_♂$) in this series was 53.3; 1009 chitons from the region of Great Sound gave a ratio $R_♂ = 54.9$; 509 from Cross Bay, a ratio $R_♂ = 50.4$. With the data arranged to show the proportion of males at each age, in these localities, a progressive variation is evident (fig. 4). At first, there is a considerable preponderance of males, which, with fluctuations suggestively parallel in the two cases, is gradually decreased, until the differential death-rate becomes effective.

The chitons above seven years of age, which tend to occur in small groups scattered along the shore, exhibit a preponderance of males. Therefore it probably comes about, as a rule, that the eggs of a given female of this age or older stand a good chance of being fertilized, since solitary individuals of maximum age are more apt to be males. Whatever of adaptational effect there may be detected in this arrangement is probably, however, not of great importance. The major share of the reproductive activity of the chiton population is carried on by individuals between five and seven years old; they are more numerous than the older ones, and the volume of the gonad is in them relatively greater than at other ages. The proportion of the sexes is here very nearly as 1:1. These animals are usually found close together in groups of a dozen or more, under stones or in crevices.

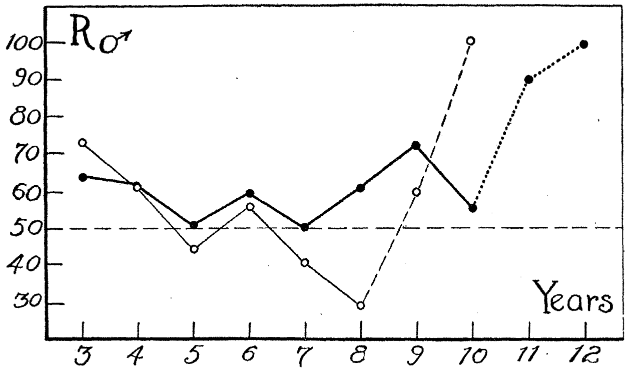

FIG. 4. VARIATIONS IN THE PROPORTION OF MALES IN DIFFERENT AGE-GROUPS OF CHITON TUBERCULATUS

● = Great Sound; ○ = Cross Bay.

Summary.—Curves have been derived which illustrate the extent to which the rate of growth and the duration of life of Chiton tuberculatus may be modified in differing natural environments at Bermuda; attention is also called to variations found in the proportion of the sexes, in different year-groups.

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[1] Contributions from the Bermuda Biological Station for Research, No. 97.

[2] Cf. Crozier, W. J., and Arey, L. B., *Amer. Jour. Physiol., Baltimore,* **46,** 1918, (487–492). Arey and Crozier, (in press).

[3] Heath, H., *Zool. Anz., Leipzig,* **32,** 1907, (10–12).

THE INTERFEROMETRY OF VIBRATING SYSTEMS

By C. Barus

Department of Physics, Brown University

Communicated, September 6, 1918

1. *Introductory.*—The high luminosity of the achromatic interferences and the occurrence of but two sharp fringes, make it possible to utilize them even in cases when the auxiliary mirrors vibrate. Experiments of a similar kind were